BAF-15303/29
32509sh

REDUCED-FRICTION ARTIFICIAL DISC REPLACEMENTS

REFERENCE TO RELATED APPLICATION

This application claims priority from U.S. Provisional Patent Application Serial No. 60/416,337, filed October 4, 2002, the entire content of which is incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates generally to prosthetic joint components and, in particular, to reduced-friction artificial disc replacements (ADRs).

BACKGROUND OF THE INVENTION

Many spinal conditions, including degenerative disc disease, can be treated by spinal fusion or through artificial disc replacement (ADR). Since spinal fusion eliminates motion across fused segments of the spine, the discs adjacent to the fused level are subjected to increased stress. The increased stress increases the changes of future surgery to treat the degeneration of the discs adjacent to the fusion.

ADRs offer several advantages over spinal fusion, the most important of which is the preservation of spinal motion. One of the most important features of an artificial disc replacement (ADR) is its ability to replicate the kinematics of a natural disc. ADRs that replicate the kinematics of a normal disc are less likely to transfer additional forces above and below the replaced disc. In addition, ADRs with natural kinematics are less likely to stress the facet joints and the annulus fibrosus (AF) at the level of the disc replacement. Replicating the movements of the natural disc also decreases the risk of separation of the ADR from the vertebrae above and below the ADR.

The kinematics of ADRs are governed by the range of motion (ROM), the location of the center of rotation (COR) and the presence (or absence) of a variable center of rotation (VCOR). Generally ROM is limited by the facet joints and the AF. Motion across prior-art prosthetic joints occurs by rotation and sliding between the components.

The resultant friction causes surface wear leading to problems well known to orthopedic surgeons (i.e., fracture of polyethylene trays, polyethylene debris, component loosening, etc.). "Revision" surgery is frequently required to correct the problems associated with component wear.

SUMMARY OF THE INVENTION

Broadly, this invention uses one or more rolling or rotating elements such as rollers or bearings to reduce the friction in an artificial disc replacement (ADR). In the preferred embodiment, the rolling or rotating elements are situated between the ADR and the vertebrae or endplate resurfacing components. The reduced friction decreases the shear stress on the vertebral endplates which, in turn, may decrease pain from the endplates. Alternatively, when used with resurfacing components, the reduced shear will prolong the life of the ADR.

In many embodiments, the inventive ADR will be tethered using a "mobile link" of the type described in co-pending U.S Patent Application Serial No. 10/426,995, the entire content of which is incorporated herein by reference. Other embodiments of the device use multidirectional, caster-like wheels not unlike those found on office chairs. The multidirectional wheels allow the ADR to move in all directions to accommodate spinal motion. The roller embodiments allow flexion and extension of the spine with movement of the ADR. Conversely, the vertebrae slide over the dome shaped rollers during lateral bending.

A preferred embodiment utilizes a spacer with wheels that rotate in all directions. Wheel rotation occurs about a transverse axle and a vertical axle that connects the wheel and transverse axle to the body of the device. Spinal movement occurs as the vertebrae move over the device. The mobile therefore device "self-centers." The body of the device could flex slightly to dampen axial loads.

The advantages of the invention are many. The use of rotating elements allows the device to move quickly to accommodate/allow spinal flexion and extension while reducing friction between the device and the vertebral endplates or between the device

and the resurfacing components. Reduced friction on the vertebral endplates could reduce pain from the endplates. Reduced friction on the resurfacing components would increase the lifespan of the device. The use of dome-shaped rollers allow at least 5 degrees of lateral bending in either direction.

In all embodiments, a seal could be used to trap debris inside the ADR. The seal could surround the periphery of the superior ADR EP and the inferior ADR EP. The seal could also hold a fluid within the ADR. Various fluids or lubricants may be used, including but not limited to: water or aqueous solutions, triglyceride oil, soybean oil, an inorganic oil (e.g. silicone oil or fluorocarbon), glycerin, ethylene glycol, or other animal, vegetable, synthetic oil, or combinations thereof could be used. The seal could be made of an expandable elastomer such as those used in medical devices for the cardiovascular system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a view of the lateral side of a device constructed in accordance with this invention;

FIGURE 2 is a view of the top of the device shown in Figure 1;

FIGURE 3 is a view of the bottom of the device of Figure 1;

FIGURE 4 is a view of the lateral aspect of the spine and the device;

FIGURE 5 is a view of the anterior aspect of the spine and the device;

FIGURE 6 is a view of the anterior aspect of the spine and an ADR that uses rollers which rotate around axles;

FIGURE 7 is view of the lateral portion of the spine and the ADR;

FIGURE 8 is a view of the lateral aspect of the device with the lateral connecting piece on the device of the present invention;

FIGURE 9 is a view of the lateral aspect of the device with the lateral plate;

FIGURE 10 is an anterior view of the spine and the device between the optional endplate;

FIGURE 11 is a lateral view of the spine and the device with the optional endplate resurfacing components.

FIGURE 12A is a view of the side an alternative component with bearings;

FIGURE 12B is a coronal cross-section of the embodiment of the device shown in Figure 12A;

FIGURE 12C is a view of the top of the embodiment of the device shown in Figure 12A;

FIGURE 12D is a coronal cross-section of an alternative embodiment of the mobile component shown in Figure 12B; and

FIGURE 12E is a coronal cross-section of an alternative embodiment of the device drawn in Figure 12D.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a view of the lateral side of a device constructed in accordance with this invention. The device has a body 102, three wheels 104 on the inferior surface and a wheel 106 on the superior surface. Figure 2 is a view of the top of the device, and Figure 3 is a view of the bottom of the device. Alternative embodiments with a different number of inferior/superior wheels are possible.

Figure 4 is a view of the lateral aspect of the spine and the device. The endplate resurfacing components 402, 404 have features, raised edges, to contain the mobile portion of the device. Figure 5 is a view of the anterior aspect of the spine and the device. The mobile portion of the device could also be connected to the inferior resurfacing component via a cable, as described in my co-pending U.S. provisional patent application Serial No. 60/376,505, the entire content of which is incorporated herein by reference.

Figure 6 is a view of the anterior aspect of the spine and an ADR that uses rollers 606 which rotate around axles 608. Alternatively, the rollers can have axle shaped projections from the ends that rotate in the lateral connecting pieces. Figure 7 is view of

the lateral portion of the spine and the ADR. The near lateral connection piece has been removed to show the inside of the roller portion of the ADR.

Figure 8 is a view of the lateral aspect of the device with the lateral connecting piece on the device. Figure 9 is a view of the lateral aspect of the device with the lateral plate 990 and a mobile link of the type referenced in the Summary of the Invention. The drawing also illustrates the use of a slot in the lateral plate. The slot allows the mobile link to travel anterior to posterior, thus increasing the mobility of the ADR in an anterior to posterior direction, without increasing the mobility of the device in a left to right direction.

Figure 10 is an anterior view of the spine and the device between the optional endplate resurfacing components described in previous disclosures. The endplate resurfacing components may preferably include raised edges to prevent the ADR from extruding or placing pressure on the Annulus Fibrosis (AF). Pressure on the AF could lead to tearing of the AF and pain.

Figure 11 is a lateral view of the spine and the device with the optional endplate resurfacing components. The lateral plate portion of the interior resurfacing component was not drawn to better illustrate the raised anterior and posterior edges of the resurfacing components. As discussed previously, the lateral plate could extend from the superior endplate component to facilitate insertion at the L4/L5 level (the screws go into the body of L4 rather than L5). Also as previously described, the plate fits over the anterior portion of S1 at the L5/S1 level and the anterior aspect of the cervical spine.

Figure 12A is a view of the side an alternative component with bearings. Unlike the component drawn in Figure 1, this embodiment of the device does not utilize axles; instead, the bearings are housed in a component with spherical holes. The bearings articulate with ADR EPs or the vertebral endplates and the component that contains the bearings. Some of the bearings articulate with the superior ADR EP or superior vertebra. Other bearings articulate with the inferior ADR EP or inferior vertebra. A single bearing articulates with either the superior or the inferior portion of the device but not both the superior and inferior portions of the device.

Figure 12B is a coronal cross-section of the embodiment of the device drawn in Figure 12A. The device was cross-sectioned through some bearings that articulate with inferior portion of the device. Figure 12C is a view of the top of the embodiment of the device drawn in Figure 12A. The bearings that articulate with the superior portion of the device are represented by the circles with solid lines. The bearings that articulate with the inferior portion of the device are represented by the circles with dotted lines.

Figure 12D is a coronal cross-section of an alternative embodiment of the mobile component drawn in Figure 12B. The device was cross-sectioned through some of the bearings that articulate with the inferior portion of the device. The inferior bearings protrude through the inferior portion of the device more than they protrude through the superior portion of the device. The superior bearings protrude through the superior portion of the device more than they protrude through the inferior portion of the device. The bearings articulate with either the superior ADR EP or the inferior ADR EP.

Figure 12E is a coronal cross-section of an alternative embodiment of the device drawn in Figure 12D. The bearings are housed in three separate components. The components that house the bearings are connected, for example by screws. Use of more than one housing component assists with the assembly of the device. The device of Figure 12 allows the bearings on the superior surface of the device to rotate in a different direction than the bearings on the inferior surface of the device.

In all embodiments, a seal could be used to trap debris inside the ADR. The seal could surround the periphery of the superior ADR EP and the inferior ADR EP. The seal could also hold a fluid within the ADR. Various fluids or lubricants may be used, including but not limited to: water or aqueous solutions, triglyceride oil, soybean oil, an inorganic oil (e.g. silicone oil or fluorocarbon), glycerin, ethylene glycol, or other animal, vegetable, synthetic oil, or combinations thereof could be used. The seal could be made of an expandable elastomer such as those used in medical devices for the cardiovascular system.

I claim: